WATER QUALITY OF THE SCUGOG RIVER

IN RELATION TO WASTE DISCHARGE

FROM THE TOWN OF LINDSAY

COUNTY OF VICTORIA

1978

Ministry
of the
Environment

Ontario

WATER QUALITY OF THE SCUGOG RIVER

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FROM THE TOWN OF LINDSAY

County of Victoria

Field Survey 1976
Report 1977

Report Prepared By
Technical Support Section
Central Region

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INTRODUCTION

At the request of staff of the Peterborough District Office a water quality survey of the Scugog River at the Town of Lindsay was undertaken during 1976. The purposes of the study were to:

1. assess the existing quality of the Scugog River and its capacity to accept additional treated effluent discharge from the Town of Lindsay

2. assess the effects of the discharge from the Town of Lindsay on the water quality of Sturgeon Lake

THE SURVEY

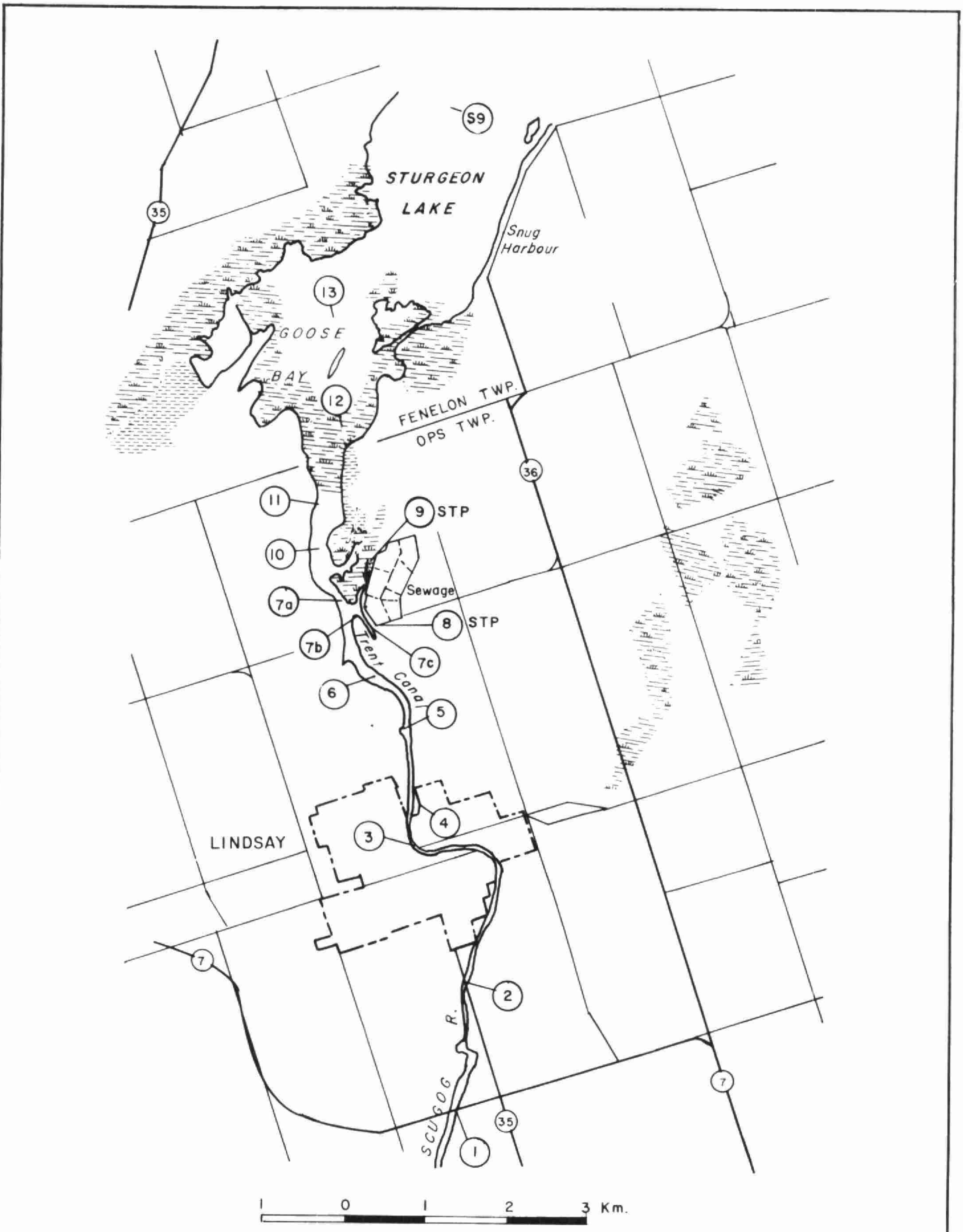
Study Area

The Town of Lindsay is located on the Scugog River approximately 100 km north east of Toronto. In 1976 the town had a population of about 13,100 people.

The Scugog River drains from Scugog Lake into the southern end of Sturgeon Lake (Figure 1). As part of the Trent Canal System the river is used by larger cruisers as well as lighter boats. The river is famous for its warm water fishery of muskellunge and yellow pickerel.

The Town of Lindsay uses the Scugog River as a source of domestic water supply. A sanitary land-fill site is located on the west bank of the river immediately north of the town. Numerous trailer parks, day parks and cottages are located along the river banks upstream and downstream of Lindsay.

The drainage basin and the river are located on Trenton, Black River Limestone bedrock. Much of the watershed is located in the Peterborough Drumlin Fields Physiographic Region, characteristic of the Kawartha area with Lake Scugog and part of the Scugog River located in the Schomberg Clay Plains Region (Chapman & Putnam 1966).



LEGEND

3 — SAMPLING STATION

9 STP - SEWAGE EFFLUENT OUTFALL

S9 .. SAMPLING LOCATION FOR KAWARTHA LAKES STUDY. 1976

MINISTRY OF THE ENVIRONMENT

FIGURE : 1

WATER QUALITY SURVEY

SCUGOG RIVER STATION LOCATIONS

SCALE : As Shown	
DRAWN BY : L.L. Broome	DATE : August, 1977
CHECKED BY : R.S.	DRAWING NO. : 7483

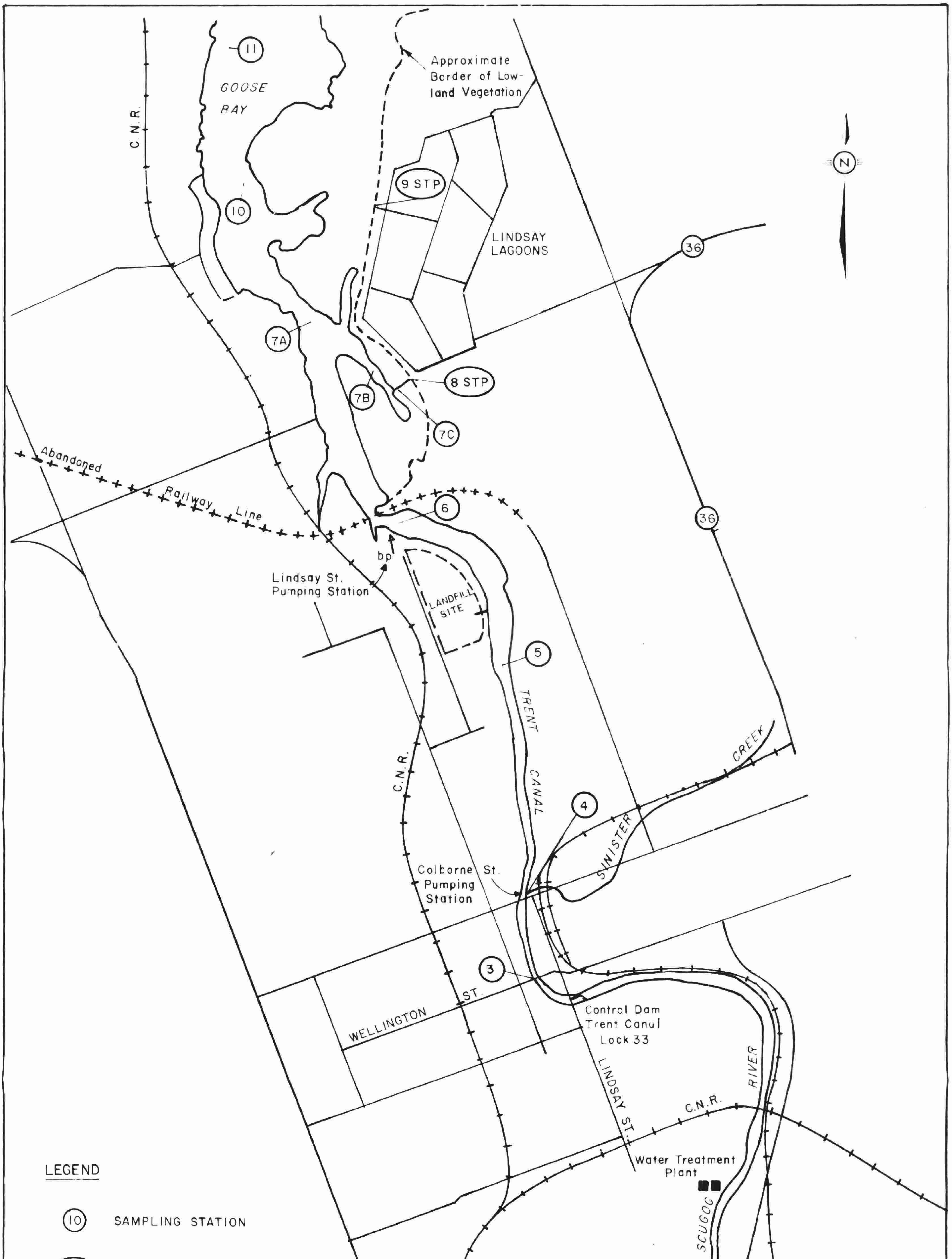
Procedures

Stations sampled during 1976 are shown in Figure 1 with more detail of the study area in Figure 2.

Routine sample runs involving dissolved oxygen and temperature measurements and the collection of water samples were carried out during the winter and summer of 1976. Because of uncertain ice conditions on the river it was impossible to sample all stations during the winter.

An intensive sampling survey was carried out from August 24 to 26, 1976. Sample runs were conducted at dawn and in the afternoon (4 runs) to obtain the diurnal fluctuation in dissolved oxygen concentrations at the sampling stations.

Dissolved oxygen concentration and temperature were determined with a YSI model 54 dissolved oxygen meter calibrated by the azide modification of the winkler method and a standard laboratory thermometer. Water samples consisted of composites through a depth of 1 meter at the deeper water stations with "grab" samples being collected at mid-depth at shallow water stations. Samples were submitted to the MOE Laboratories Branch at Rexdale.



MINISTRY OF THE ENVIRONMENT	
FIGURE 2 SCUGOG RIVER WATER QUALITY SURVEY 1976	
SCALE: AS SHOWN	
DRAWN BY: L. BROOME	DATE: FEB. 1978
CHECKED BY: K.S.	DRAWING Nº: 7964

Analyses were conducted for: BOD_5; total and dissolved reactive phosphorus; free ammonia, total Kjeldahl nitrogen, nitrite and nitrate nitrogen; chloride; sulphates; suspended solids and conductivity. Standard analytical methods were used by laboratory staff.

BACKGROUND INFORMATION

Long Term River Water Quality

Water quality monitoring information for the Scugog River was available for two locations corresponding approximately to Station 2 and Station 10A (monitoring stations 17-0021-042-02 and 17-0021-041-02). Median values for the period 1970 to 1976 are presented in Appendix 1.

The water chemistry changed very little from year to year at the upstream station. This was especially evident in the chloride concentrations which ranged between 10 and 12 mg/l over the seven years. Total phosphorus concentration, total Kjeldahl nitrogen concentration and nitrate nitrogen concentration were relatively high, typical of enriched waters. Median BOD_5 concentrations ranged between 1.6 and 3.5 mg/l over the years, also indicating enriched conditions.

At the downstream station greater fluctuation in water quality was evident from year to year. Chloride concentrations varied between 14 and 26 mg/l. Nutrient concentrations were generally higher than upstream. Total phosphorus ranged between 0.056 and 0.460 mg/l while the soluble fraction was sharply increased over the upstream station. BOD_5 concentrations reflected an increase in organic inputs to the River from the town of Lindsay (range of 2.4 to 5.5 mg/l).

River Phytoplankton

Information on the phytoplankton densities and composition in the Scugog River have been gathered for several years by staff of the Lindsay Water Works (Figure 2). The dominant genera for the past 9 year period (1968 to 1976) were Oscillatoria, Lyngbya and Aphanizomenon. The seasonal fluctuation in algal density at this point in the River has generally been at a minimum in the spring and a maximum in the late fall or early winter. A mean density of 11, 238 a.s.u./ml. was found during 1976 and was comparable to a nine year average of 12,645 a.s.u./ml. (for the period 1968 to 1976).

Both the phytoplankton density and composition were typical of very enriched conditions. It should be noted from these results that the river was enriched above any discharges from the Town.

Previous Assimilative Capacity Study

A waste assimilative capacity study of the Scugog River at Lindsay was conducted by staff of the Ontario Water Resources Commission during 1970 and 1971. As a result of this study, the recommended BOD loading from the sewage lagoons was set at 350 pounds per day to avoid dissolved oxygen problems in the river downstream of the discharges. It was noted in the report that a considerable increase in the phosphorus concentration in the river downstream of the lagoons was occurring. The marsh areas into which the lagoons discharged were reducing organic and nutrient materials before flow reached the main river.

Sturgeon Lake

Water Quality information on Sturgeon Lake was available from the 1971 Recreational Lakes Survey and the Kawartha Lakes Water Management Study (1976). Water Quality results and other data on Sturgeon Lake are summarized in Appendix 2. In general the reports showed that there was a significant difference in water quality between the west arm of the lake and the east and south arms. The lake in general was considered to be bordering eutrophic conditions based on phosphorus, Secchi disc, chlorophyll _a_ and phytoplankton results. Blue-green algae predominated in the phytoplankton composition of Sturgeon Lake, especially the bloom-forming species such as _Anabaena_, _Aphanizomenon_, _Microcystis_, _Oscillatoria_ and _Lyngbya_. M.O.E. staff have received numerous complaints concerning the water quality of the Scugog River and Sturgeon Lake in recent years. Most complaints relate to nuisance growths of algae in these water bodies.

HYDROLOGY

The Scugog River, draining Scugog Lake s approximately 22 Km. to Goose Bay in the sou of Sturgeon Lake. The River level is controll Parks Canada at a dam and lock in the Town of Lin There is little gradient in the river. The wate level upstream of the dam at Lindsay is approximatel the same as that of Lake Scugog while downstream of the dam the level is similar to Sturgeon Lake. Low flow in the river at the dam was estimated by the Central Region Hydrologist to be about 0.085 m^3/sec. or 3 cfs. Industrial flow via Sinister Creek and miscellaneous flow occurring from the dam to the point where effluent discharge occurs was estimated to be about 0.028 m^3/sec. or 1 cfs. from District Office information. The low flow upstream of the lagoon discharge was about 0.113 m^3/sec. or 4 cfs.

For purposes of calculating the yearly phosphorus budget for Sturgeon Lake relative to the Lindsay discharge, the figures for Sturgeon Lake from the Kawartha Lakes Water Management Study were used. Table 1 summarizes flow data used in this report.

TABLE 1 FLOW DATA FOR THE SCUGOG RIVER AND STURGEON LAKE

Low Flow	
Flow at dam in Lindsay	0.085 m^3/sec (3 cfs)
Industrial flow via Sinister Creek and Misc. flow	0.028 m^3/sec (1 cfs)
Total Upstream Flow (Qus)	0.113 m^3/sec (4 cfs)
Average sewage flow during August 1976 (QSTP)	0.116 m^3/sec (4.1 cfs)
Total Downstream Flow (Q_{DS})	0.229 m^3/sec (8.1 cfs)
Yearly Flow	
Scugog River* (not including sewage flow)	193.2 x $10^6 m^3$
Outlet from Sturgeon Lake*	1430 x $10^6 m^3$
Total discharge from lagoons during 1976	4.43 x $10^6 m^3$

* from Kawartha Lakes Water Management Study (1976)

LINDSAY WATER POLLUTION CONTROL PLANT

During 1976, sewage from the town was treated at a series of lagoons or waste stabilization ponds and continuously discharged to the Scugog River. Six cells totalling about 44 Ha (109 acres) ~~in area,~~ received sewage from the town. The sewage flow from the town often exceeded the pumping capacity of the Lindsay Street pumping station and frequent "by-passes" of untreated sewage occurred. Fortunately, this situation has been alleviated by the construction of an additional forcemain carrying sewage to the lagoons. The quantity of sewage by-passed during the survey is unknown.

Sewage pumped to the lagoons was circulated through six cells (two sets of 3 cells each) and discharged at two locations (Figure 2). Because of irregularities in connections between cells that were discovered after the field survey, the ratio of flow from the two outfalls is unknown.

A summary of sewage flow from plant monitoring results is given in Appendix 3. The mean monthly flows were calculated after eliminating anomalous values from the daily operating data.

From available information on effluent quality the mean monthly concentrations of BOD_5, suspended solids, Total Kjeldahl nitrogen (TKN) and total phosphorus at Station 8STP were calculated (Appendix 4). The effluent from this discharge met Ministry effluent criteria for BOD_5 and suspended solids.

Total phosphorus values met the present Minsitry criteria of 1 mg/l for only 3 months with a year average concentration of 1.85 mg/l.

Much less information was available for Station 9 STP but in general values for Suspended Solids, Total phosphorus and TKN were similar to the south outfall. BOD_5 concentration at this station was consistently higher than that of station 8STP and probably related to the irregularities in cross connections between the cells of this series.

During the winter months the lagoon effluents were high in phosphorus. The probable cause of this is that the lagoons were ice and snow covered during this period, creating anaerobic conditions in the lagoons which facilitated the release of phosphorus from the sediments. The anaerobic conditions were confirmed by the presence of very strong H_2S odour at the effluents during winter. Presumably, if ice was prevented from forming, aerobic conditions could be maintained in the lagoons and phosphorus would be retained in the sediments.

DISCUSSION OF RESULTS

Two significant impacts of sewage effluent discharges to rivers and lakes are: 1. the reduction of dissolved oxygen available for use by aquatic organisms and 2. the addition of plant nutrients that may aggravate aquatic plant growths in downstream waters. From the survey results (Appendix 5) dissolved oxygen, BOD_5, phosphorus and nitrogen have been chosen for discussion in the following subsections.

Dissolved Oxygen

Dissolved Oxygen in rivers is vital for the existence of fish and other aquatic organisms. The Ministry guideline for dissolved oxygen concentration requires a minimum of 5 mg/l to support a warm-water fishery.

During the winter, dissolved oxygen under ice cover in the main channel of the River was above 6 mg/l upstream and downstream of the lagoon discharge. No decreasing trend downstream of the discharge was evident in February and March (Figure 3A).

In June and July, fluctuations in dissolved oxygen were noted starting from Station 5 (Figure 3B and 3C). It was evident in July that a "sag" or decrease in the dissolved oxygen concentration occurred downstream of the sewage discharge with a minimum in the surface waters of 7.4 mg/l. At a depth of 1 meter a minimum occurred at Station 5 and at Station 10A (2.8 mg/l and 3.8 mg/l respectively).

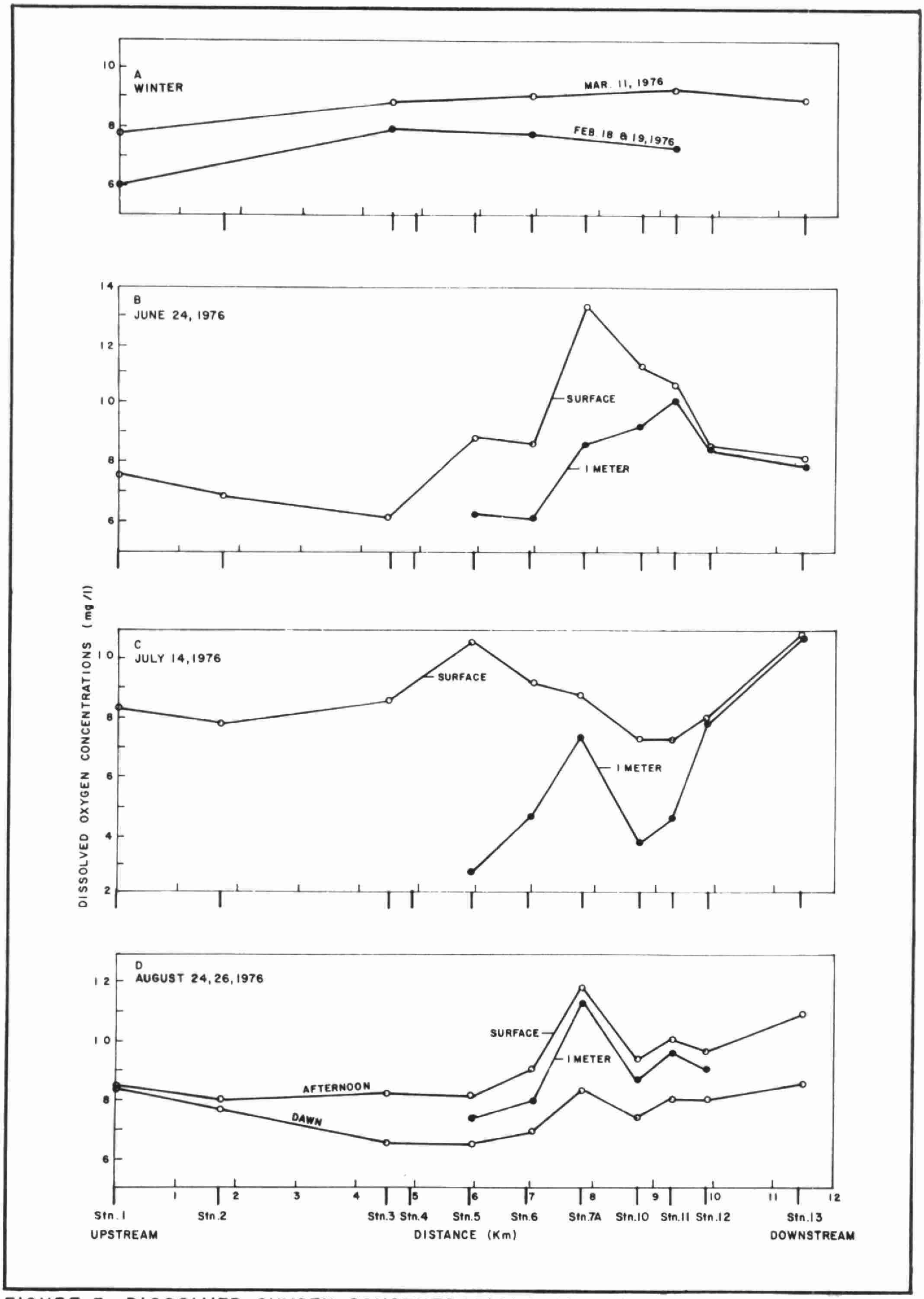


FIGURE 3 : DISSOLVED OXYGEN CONCENTRATIONS AT STATIONS IN THE SCUGOG RIVER - MAIN CHANNEL

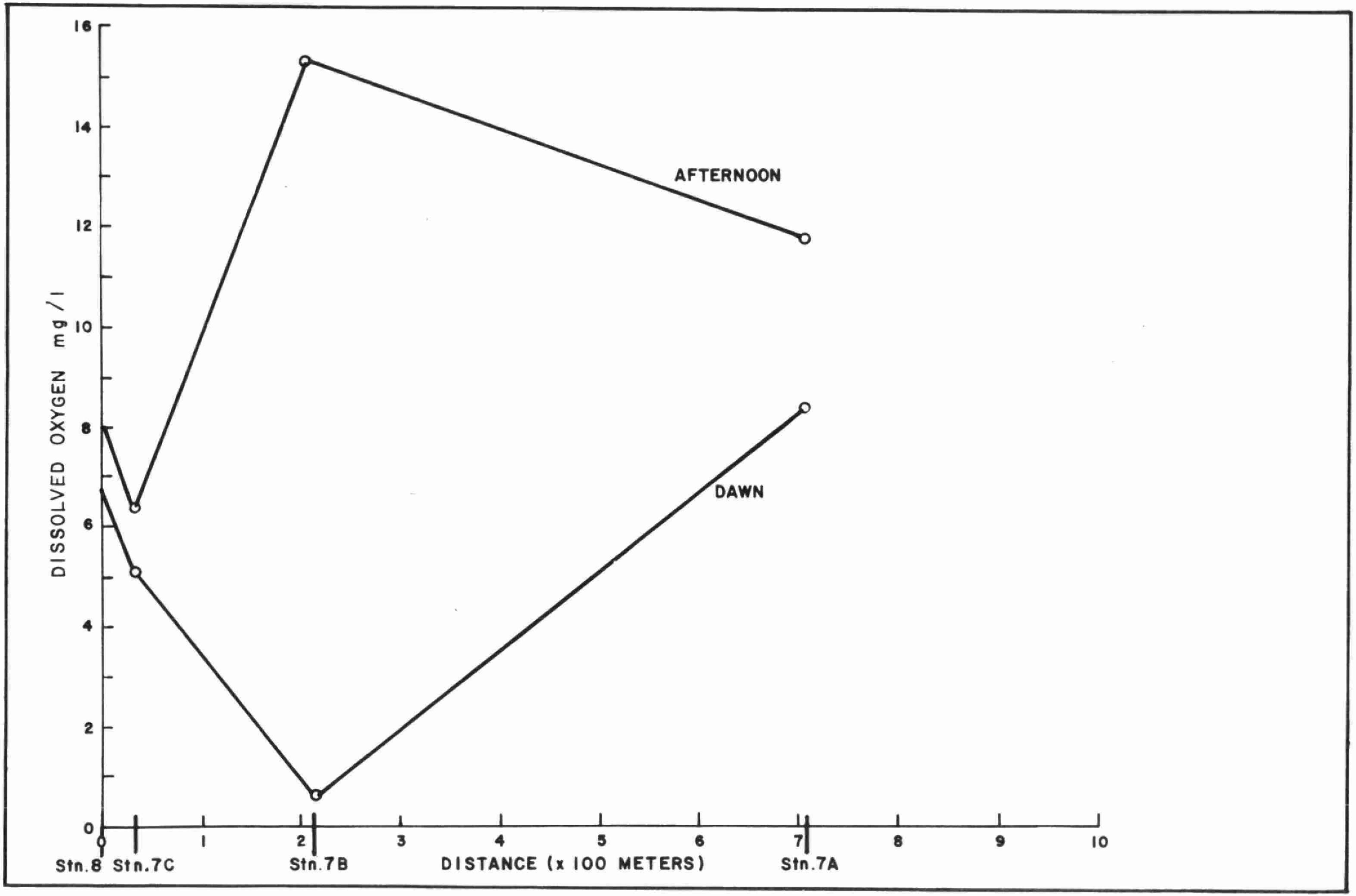


FIGURE 4 A: DISSOLVED OXYGEN CONCENTRATION FROM THE SOUTHERN LAGOON OUTFALL TO STATION 7A AUGUST 24-26, 1976

Dissolved oxygen was in excess or supersaturated especially in surface waters during the summer. The maximum value on June 24 was 13.3 mg/l or 150% saturation at Station 7A. The high daytime concentrations in the surface waters were probably due to production of oxygen by phytoplankton. Because the turbidity of the water reduced light penetration, less production was possible at 1 meter depth and daytime dissolved oxygen concentrations were lower than at the surface. Another contributing factor to the decrease may have been the oxygen demand of the sediments.

During the intensive August survey, dissolved oxygen concentration was relatively stable upstream of Station 6, rose to a peak at Station 7A and declined again at Station 10A. Figure 3 also indicates the daily fluctuation of dissolved oxygen concentration with high daily values reached in the afternoon and the low values (both surface and 1 meter) occurring during the night and at dawn.

The dissolved oxygen concentrations of the bay into which sewage was discharged fluctuated widely during the intensive survey as indicated in Figure 4. The minimum dissolved oxygen concentration measured in the bay during the intensive was 0.6 mg/l at Stations 7B.

In summary, the lagoon discharges were having a significant effect on the dissolved oxygen concentration in the localized bays receiving the treated effluent. The discharge from the bays was having a measureable effect on dissolved oxygen in the main river with more fluctuating concentrations occurring downstream of the lagoon discharges.

Biochemical Oxygen Demand

Bacterial decomposition of organic material in the aerobic aquatic environment utilizes oxygen. With the added organic material from the treated sewage waste, bacteria use more oxygen for decomposition. The most frequent effect of discharge of wastes to water-bodies is the reduction of dissolved oxygen concentration to levels which cannot support normal aquatic life. A measure of this oxygen demand is the 5 day biochemical oxygen demand or BOD_5 concentration (defined as the dissolved oxygen required for the aerobic bacterial stabilization of decomposable organic matter in a 5 day period). An objective that is often used by this Ministry for the maximum BOD_5 concentration in a water body is 4 mg/l. Concentrations above this value may reduce the dissolved oxygen concentration below the Ministry guideline of 5 mg/l and may also cause objectionable aesthetic problems.

Upstream in the study area (at Stations 1, 2 and 3) the BOD_5 concentration during the survey ranged between 0.8 and 4.8 mg/l with average values during the intensive survey of 2.5 to 3.2 mg/l. BOD_5 concentrations during the intensive survey in the main river rose to an average value of 3.6 mg/l at Station 7A; approaching the objective of 4 mg/l (See Figure 5A).

The BOD_5 concentration in the bay receiving the southern discharge exceeded the ministry objective

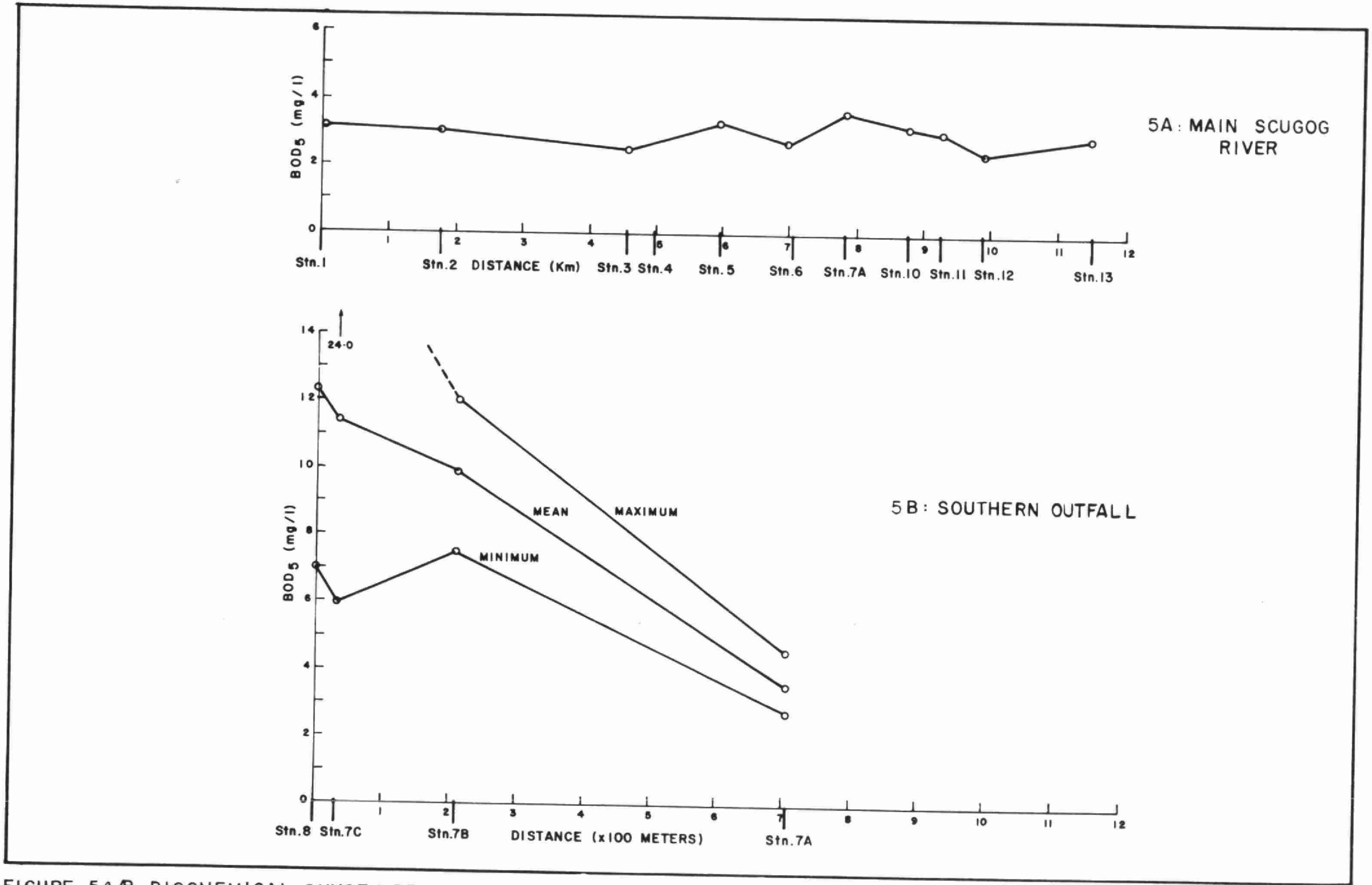


FIGURE 5A/B: BIOCHEMICAL OXYGEN DEMAND IN MAIN SCUGOG RIVER AND FROM SOUTH OUTFALL TO STATION 7A AUGUST 24-26, 1976

on all but one occasion during the survey (see Figure 5B).

It appears that BOD_5 concentrations were high in the bays receiving the discharge but that concentrations were reduced by the time the water moved out into the main river. River concentrations downstream of the discharge bay, however, were approaching 4 mg/l.

Phosphorus and Nitrogen

Phosphorus has been identified as the key nutrient limiting aquatic plant growth in the Kawarthas. Phosphorus concentrations in the main river as illustrated in Figure 6, show a definite relationship to the discharge from the sewage lagoons with a peak river concentration of 0.154 mg/l during the intensive survey at Station 7 A.

As with BOD_5, phosphorus was present in higher concentrations in the bays receiving lagoon effluent. High concentrations were evident at Station 7B in the south bay.

Nitrogen is another essential nutrient for aquatic plant growth. The various forms of nitrogen in the aquatic environment indicate the extent to which aerobic decomposition has taken place. Under natural conditions most nitrogen will be found in the organic form ($TKN-NH_3$ = organic nitrogen), tied up in living plants and animals or other organic matter. When organic matter is decomposed the first product is usually ammonia. This becomes oxidized to nitrite (NO_2); then to nitrate (NO_3) which in turn becomes incorporated into living material.

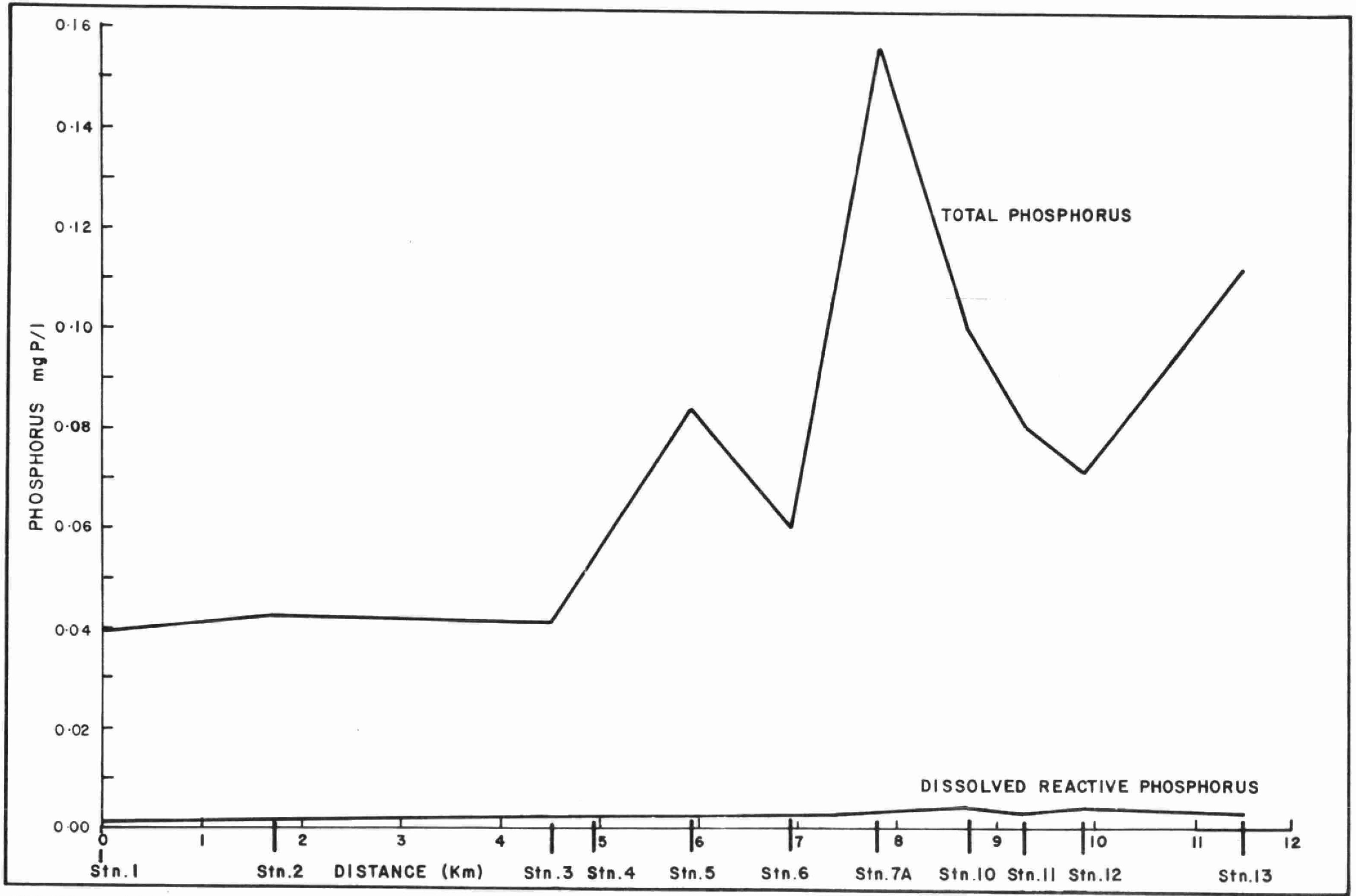


FIGURE 6: TOTAL AND DISSOLVED REACTIVE PHOSPHORUS IN THE MAIN SCUGOG RIVER AUGUST 24-26, 1976

Where waste discharges are present, the treated sewage should be well oxidized before discharge to prevent excessive usage of dissolved oxygen in the receiving water body. During the winter, an increasing trend in the concentration of ammonia nitrogen was evident in the river downstream of the lagoon discharges (see Figure 7A). Other forms of nitrogen were relatively constant at all stations.

During the August intensive survey, the average organic nitrogen concentration reached a definite peak of 1.226 mg N/l at Station 7A, coinciding with the lagoon discharge (see Figure 7B). Nitrate concentration during the same period was generally less than 0.005 mgN/l at all stations in the main river.

The average concentration of ammonia reached a peak of 0.065 mg N/l at Station 5 during the intensive that probably resulted from the discharge of industrial wastes via Sinister Creek. Relatively high cencentrations were noted at Station 4 on Sinister Creek, just before discharge to the Scugog River (1.35 mg N/l during the August intensive). This source of ammonia merits further investigation. Only a slight elevation in ammonia concentration over the upstream stations was noted near the lagoon discharge bays (Station 7A).

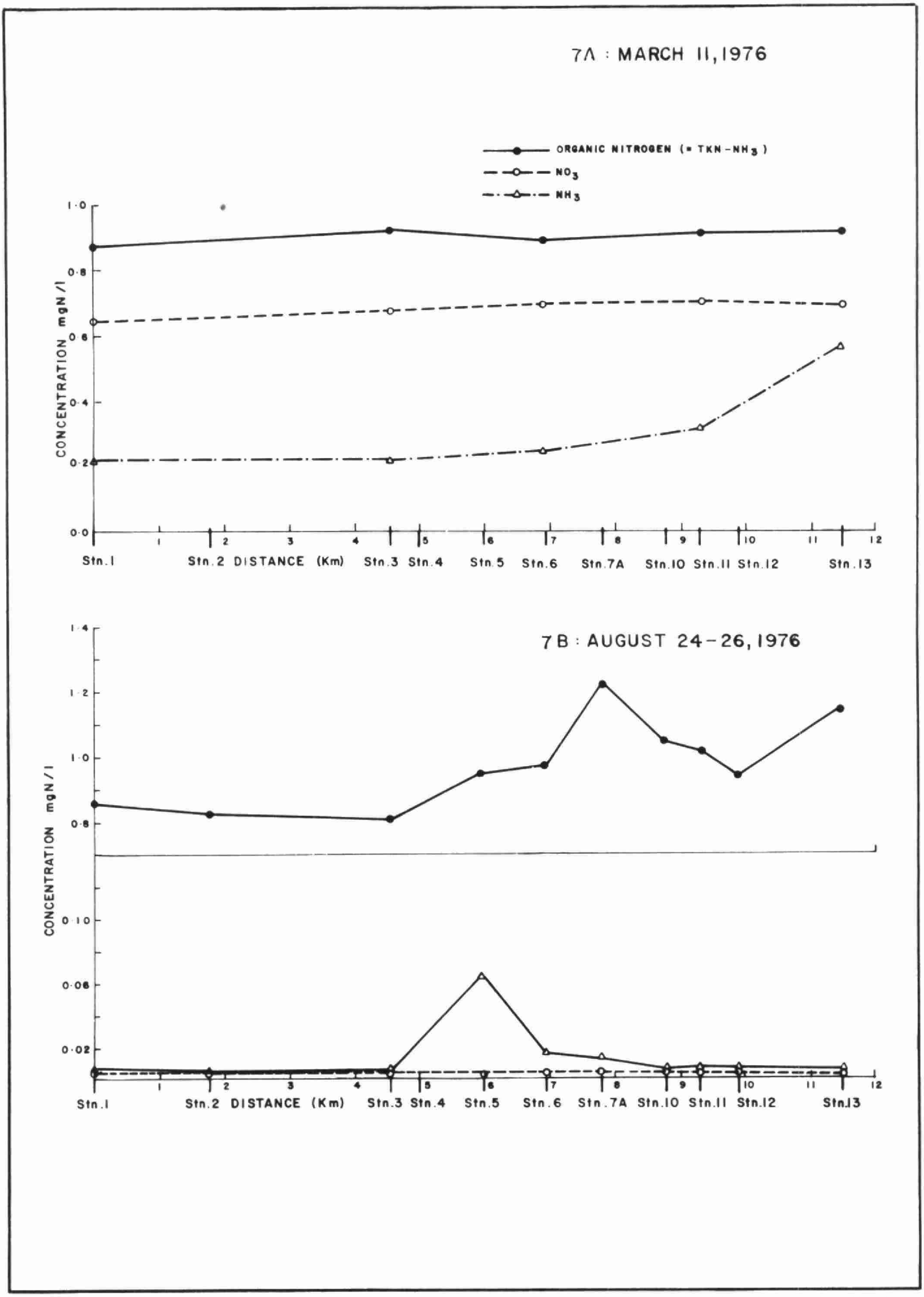


FIGURE 7A / B : ORGANIC NITROGEN, NITRATE NITROGEN AND FREE AMMONIA IN THE MAIN SCUGOG RIVER MARCH 11, AND AUGUST 24 - 26, 1976

Slightly elevated concentrations of ammonia were noted in the discharge bays, despite relatively high concentrations in the effluent. Organic nitrogen concentrations indicated that the bays were reducing the organic content of the effluent before it reached the main river.

WATER QUALITY OF THE SCUGOG RIVER IN RELATION TO LAGOON DISCHARGES

On the basis of the background information and the survey results, the Scugog River was considered an enriched system. Water quality findings upstream of any discharge from the Town of Lindsay have indicated that the river is enriched before it reaches the town. Further organic and nutrient input from the town aggravated this situation.

The bays receiving the two discharges from the lagoons have been shown to be very important in reducing the concentration of organic materials (via dilution, settling, assimilation by aquatic plants, etc.) before the effluent reaches the main River. If the bays are altered in any way (such as channelization through dredging, removal of Cattail marsh, etc.) the reduction in BOD_5 and nutrient concentration would be affected resulting in serious water quality effects downstream of the discharges. The following table shows the importance of the bays and the effects, in terms of the downstream BOD_5 concentration, that would result from any alteration of existing conditions (Appendix 6).

% reduction provided by bays	BOD_5 concentration downstream (mg/l)
70	3.6 (existing)
50	5.2
30	6.7
0	8.9

WATER QUALITY OF STURGEON LAKE
IN RELATION TO LAGOON DISCHARGE

From the phosphorus budget for Sturgeon Lake in the Kawartha Lakes Water Management Study and survey results, a revised phosphorus budget was calculated for Sturgeon Lake. The proportion of phosphorus supply from various sources for 1976 was estimated to be as follows:

Source	kg/yr	% of total supply
Lindsay lagoons	8,200	19
Fenelon Falls STP	400	1
Other local inputs	1,100	3
Main Channel input	16,200	37
Scugog River (not including lagoons)	13,070	30
Overland drainage to Lake	3,430	8
Precipitation	1,050	2
Total Supply	43,450	

The budget shows that the input of phosphorus from the Lindsay Lagoons represents about 19% of the 1976 total supply. Assuming that treatment at the lagoons (and at Fenelon Falls STP) will be improved to meet the MOE guideline for effluent phosphorus concentration of 1 mg/l the phosphorus supply to the lake should remain about the same as that of 1976 with an increased population to 17,250 people in the Town (Appendix 7).

Dillon's model (1974) was also used to predict the resulting lake water quality changes that would be expected from the various phosphorus supply options. (Appendix 7). The degree of change estimated from the model for an increase in population in Lindsay to 17,250 with improved treatment to meet the present MOE guidelines was small (5%) and may not be measure-able. With an effluent of 0.3 mgP/l as recommended in the draft report of the Kawartha Lakes Strategy Committee, a slight improvement in water quality is expected.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

1. A survey of the water quality of the Scugog River at Lindsay was conducted during 1976 to assess the effects of the discharge from the Town of Lindsay lagoons.

2. The water quality information indicated that the Scugog River was very enriched upstream of any discharge from the town of Lindsay and that further enrichment was occurring as a result of the lagoon discharges.

3. The water quality of Sturgeon Lake was characterized by enriched conditions that relate in part to phosphorus input from the Scugog River and Lindsay. Nuisance phytoplankton growths in the lake have been identified as an important concern.

4. The phosphorus input to Sturgeon Lake from the lagoon discharges was estimated to be about 19% of the total supply to the lake. With improved treatment at the lagoons and despite a population increase to 17,250 only a slight change in the water quality of Sturgeon Lake is expected. Phosphorus removal at the lagoons should be improved to meet the present ministry criteria of 1 mg P/l of total phosphorus in the effluent. Should the recommendation of the Kawartha Development Strategy Committee draft report become policy, a new objective of 0.3 mg P/l total phosphorus will be required.

5. The organic loadings were significantly reduced in the bays receiving lagoon effluent before the effluent reached the main river. Every effort should be made to maintain these bays in their present condition. Further study of the discharge bays could be undertaken to determine how best to enhance their reducing effect. In future it may be possible to promote types and densities of aquatic vegetation which would maximize the waste polishing ability at the area.

6. It is recommended that improvement of the treatment during the winter at the lagoons be investigated. The feasibility of keeping the ice from forming on the last 2 cells in each series to promote aerobic conditions, could be investigated.

7. The source of ammonia noted in Sinister Creek is being further investigated by the Ministry.

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MOE 1976 : The Kawartha Lakes Water Management Study - Water Quality Assessment (1972-1976), M.O.E. report.

Appendix 1 Long term river water quality data (median values)

Scugog River Station 17-002104202 at Hwy 7B, Lindsay

DATE	D.O. (mg/l)	Temp (°C)	BOD_5 (mg/l)	Bacteria/100ml T.C.	F.C.	F.S.	Phosphorus Total (mg P/l)	Sol.	Nitrogens (mg/l) F.A.	Kjel	Nitrite	Nitrate	Turb. (J.T.U. &F.T.U.)	Cond. (umhos/cm^3)	Cl (mg/l)
1970	9.0	15.0	3.5	70	-	-	0.095	0.002	0.04	1.20	0.002	0.010	10	378	10
1971	8.0	15.5	3.0	156	-	-	0.048	0.002	0.04	0.98	0.004	0.020	6	387	11
1972	9.0	12.3	2.5	232	16	16	0.042	0.002	0.13	1.40	0.008	0.210	6	380	11
1973	9.5	20.0	1.9	245	28	12	0.047	0.002	0.13	1.10	0.008	0.260	3.80	380	12
1974	10.0	18.0	1.6	2100	15	L10	0.038	0.002	0.05	0.98	0.005	0.300	2.60	390	11
1975	9.5	9.0	2.6	100	10	L10	0.045	0.002	0.09	1.20	0.004	0.030	3.30	380	10
1976	9.0	4.0	1.8	160	4	4	0.034	0.001	0.073	1.08	0.004	0.208	4.75	345	11

Scugog River Station 17-0021-041-02 Downstream of Lindsay Lagoons

DATE	D.O. (mg/l)	Temp (°C)	BOD_5 (mg/l)	Bacteria/100ml T.C.	F.C.	F.S.	Phosphorus Total (mg P/l)	Sol.	Nitrogens (mg/l) F.A.	Kjel	Nitrite	Nitrate	Turb. (J.T.U. &F.T.U.)	Cond. (umhos/cm^3)	Cl (mg/l)
1970	7.0	17.0	5.5	880	-	-	0.46	0.100	1.60	4.40	0.044	.120	10	565	26
1971	9.5	17.2	2.5	2400	-	-	0.210	0.110	0.43	1.80	0.024	.210	8	454	16
1972	8.5	16.0	3.0	1900	188	40	0.067	0.002	0.41	1.50	0.006	.230	10	389	15
1973	11.5	19.5	4.3	700	84	L10	0.215	0.040	0.040	2.00	0.014	.385	5.35	482	20
1974	7.5	19.0	2.4	7800	340	L10	0.160	0.076	0.44	1.40	0.029	0.340	4.55	439	20
1975	10.0	9.0	3.4	100	L10	L10	0.088	0.004	0.28	1.70	0.006	0.200	5.50	410	17
1976	10.0	6.0	2.7	930	60	16	0.056	0.002	0.414	1.435	0.007	0.420	4.25	378	14

Appendix 2 INFORMATION ON STURGEON LAKE

Lake Surface Area (Al)	47.1 Km^2
Lake Volume (V)	1.63×10^8 m^3
Mean Depth ($\bar{z}$)	3.5_m

Station	Total Phosphorus (ug/l)			Chlorophyll a (ug/l)			Secchi Disc (m)			Phytoplankton (mm^3/l)		
	1971	1972	1976	1971	1972	1976	1971	1972	1976	1971	1972	1976
S-7 (West arm)		22	18	3.6	4.9	4.6	2.7	2.4	2.1	1457*	2.7	1.8
S-8 (Sturgeon Pt.)		29	21	7.5	9.1	7.8	2.2	2.3	2.3	2068	-	-
S-9 (South arm)		30	41	7.7	8.3	13.2	1.9	2.0	1.4	3765	5.4	3.4

1971 information from the Recreational Lakes Program Report on Sturgeon Lake 1971

1972 & 76 information from the Kawartha Lakes Water Management Study (1976)

*1971 values for phytoplankton in a.s.u./ml. unpublished MOE data

APPENDIX 3   Monthly flow data for the Lindsay Lagoons 1976

Month	mean daily flow (m^3/day)	monthly flow (m^3)
Jan.	9,605	297,750
Feb.	11,510	333,790
Mar.	17,388	539,030
Apr.	15,283	458,490
May	14,638	453,780
Jun.	12,247	367,410
Jul.	11,228	348,070
Aug.	9,856	305,540
Sept.	10,119	303,570
Oct.	10,528	326,370
Nov.	10,692	320,760
Dec.	12,265	380,215
mean	12,113	4,434,770

APPENDIX 4 LINDSAY LAGOONS - mean monthly effluent concentrations for the south outfall during 1976.

Month	Number of Samples	BOD_5 (mg/l)	Suspended Solids (mg/l)	TKN (mgN/l)	Total Phosphorus (mgP/l)
Jan.	*	18.8	21.0	22.90	4.71
Feb.	5	18.8	21.0	22.90	4.71
Mar.	2	12.5	12.0	13.90	1.87
Apr.	3	12.3	52.7	8.5	1.25
May	7	3.0	10.2	2.87	0.71
June	5	7.1	15.8	5.48	1.39
July	3	6.7	16.0	4.92	1.13
Aug.	8	9.0	18.8	4.46	0.93
Sept.	3	6.5	21.7	4.63	0.91
Oct.	3	5.3	6.3	6.40	1:23
Nov.	4	5.9	7.8	10.95	1.33
Dec.	2	18.0	11.5	16.00	2.05
mean		10.3	17.9	10.33	1.85

* no samples, assumed same as February (from 1977 January results this is reasonable).

Appendix 5 Survey Results

STATION 1

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (°C)	BOD_5 (mg/l)	PHOSPHORUS (mg p/l) Total	Sol.	NITROGEN F.A.	TKN.	NO_2	NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm^3)
Feb 18 & 19		surf.	6.1	0.2	2.8	.030	.001	**	1.53	.004	.271	12	22	8.1	**
Mar 11		"	7.8	0.0	1.6	.031	<.001	.216	1.09	0.010	.640	10.5	30.5	9.9	390
Jun 24	8:15	"	7.6	24.0	0.8	.029	.001	.010	.94	.003	.007	8.6	15	4.2	330
Jul 14	9:15	"	8.3	18.8	1.2	.025	.002	.228	.94	.005	.025	9.3	18.5	6.5	344
Run #1 Aug 24	17.36	"	8.5	26.0	3.6	.034	<.001	.006	.87	.001	<.005	10	17.5	9.8	305
Run #2 Aug 25	05:10	"	8.3	22.7	3.6	.041	.001	.014	.85	.001	<.005	9.5	17.5	9.7	305
Run #3 Aug 25	20:00	"	8.3	25.0	3.0	.040	.001	.008	.88	.001	<.005	10	16	8.5	300
Run #4 Aug 26	03:50	"	8.5	23.0	2.4	.040	.002	.004	.86	.001	<.005	10	17	8.0	300

STATION 2

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (°C)	BOD_5 (mg/l)	PHOSPHORUS (mg p/l) Total	Sol.	NITROGEN F.A.	TKN.	NO_2	NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm^3)
Jun 24	8:40	surf.	6.9	24.8	2.8	.038	.002	.006	.94	.002	<.005	10	15.5	8.2	332
Jul 14	8:50	"	7.8	18.3	1.0	.031	.001	.220	.89	.005	.020	9.4	18.5	.0	340
Run #1 Aug 24	17:43	"	8.4	26.0	4.8	.048	<.001	.004	.82	.002	<.005	10	17.5	11	310
Run #2 Aug 25	05:20	"	7.6	22.7	2.4	.040	.001	.002	.85	.001	<.005	10	17.0	11	310
Run #3 Aug 25	19:50	"	7.6	24.8	2.8	.042	.001	.008	.86	.001	<.005	10.5	16.0	11	310
Run #4 Aug 26	03:55	"	7.8	23	2.0	.038	.002	.004	.80	.001	<.005	10	17	10	310

Appendix #5 (continued)

STATION 3

DATE	TIME	SAMP. DEPTH		D.O. (mg/l)	TEMP. (^{o}C)	BOD_5 (mg/l)	PHOSPHORUS TOT. (mg p/l)	PHOSPHORUS SOL. (mg p/l)	NITROGEN F.A.	NITROGEN TKN.	NITROGEN NO_2	NITROGEN NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	Susp. Solids (mg/l)	COND. (umhos/cm^3)		
Feb. 18 & 19		surf.		7.9	0.8	2.4	.034	.001	.410	1.44	.004	.220	16		11	405		
Mar. 11		"		8.8	0.0	1.4	.036	<.001	.214	1.14	.010	.675	11.5	31.0	11	395		
June 24/76	8:50	"		6.2	24.0	2.4	.061	.001	.940	1.76	.003	<.005	12.5	44	9.2	413		
July 14	9:20	"		8.6	19.1	1.2	.034	.001	.318	2.55	.005	.030	9.4	18.5	11	337		
RUN #1 Aug. 24	17:54	"		8.6	25.0	2.8	.031	<.001	.006	.65	.001	<.005	10	17.5	11	315		
RUN #2 Aug. 25	05:40	"		6.4	22.3	2.4	.047	.002	.002	.92	.002	<.005	10	18.5	11	322		
RUN #3 Aug. 25	19:45	"		7.8	25.0	2.8	.050	.001	.010	.88	.001	<.005	10.5	17	11	320		
RUN #4 Aug. 25	04:05	"		6.7	22.8	2.0	.038	,001	.004	.80	.001	<.005	10.5	23	9.9	330		
				STATION #4														
June 24	9:00	Surf.		4.7	27.0	2.8	.076	.003	82.0	93.0	.015	.005	28	2500	5.0	4850		
July 14	9:30	"		7.6	17.9	6.0	.038	.002	41.0	41.5	.088	.037	27	4125	7.3	4925		
RUN #1 Aug. 24	17:15	"		5.0	29.5	2.8	.039	.001	1.02	1.65	.026	.039	25.5	2400	5.4	4400		
RUN #2 Aug. 25	05:50	"		5.4	22.3	4.4	.081	.002	1.28	2.30	.011	<.005	24	2350	13	4325		
RUN #3 Aug. 25	19:35	"		4.4	28.0	4.0	.044	.001	1.15	1.94	.006	<.005	26	475	6.3	4350		
RUN #4 Aug. 26	04:10	"		4.6	24.5	7.0	.132	.009	1.95	3.1	.007	.008	26.5	3000	9.3	4700		

KS:mn

STATION 5

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (^oC)	BOD_5 (mg/l)	PHOSPHORUS Total (mg p/l)	PHOSPHORUS Sol. (mg p/l)	NITROGEN F.A.	NITROGEN TKN.	NITROGEN NO_2	NITROGEN NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm^3)
Feb 18 & 19	—														
Mar 11	—														
Jun 24	11:15	surf 1m*	8.9 6.3	24 24	5.5	.106	.002	4.40	6.40	.015	.125	14.5	170	15	600
Jul 14	11:30	surf 1m*	10.6 2.8	19.3 19.3	1.4	.038	.001	.75	2.20	.005	.030	9.5	37.5	12	390
Run #1 Aug 24	20:07	surf 1m	8.4 7.3	26 25	2.2	.047	.001	.004	.94	.002	<.005	10		13	385
Run #2 Aug 25	06:20	surf 1m	6.1 6.1	22.6	6.0	.174	.001	.120	1.10	.002	<.005	10	95	13	390
Run #3 Aug 25	17:00	surf 1m	7.8 7.4	25.0	3.0	.062	.002	.030	1.02	.002	.008	11	70	14	420
Run #4 Aug 26		surf 1m	6.9 6.8	24.0	2.0	.052	.002	.064	1.00	.002	.009	11	80	11	450
						STATION 6									
Feb 18 & 19		surf comp-1m	7.7	0.5	3.2	.048	.001	.630	1.78	.005	.245	19	-	9.5	425
Mar 11		1m	9.0	0.0	2.2	.041	.001	.240	1.13	.010	.695	13.5	33	7.4	415
Jun 24	11:25	surf 1m*	8.7 6.1	24.5 240	7.5	.50	.020	4.10	8.40	.042	.218	24	150	18	630
Jul 14	11:40	surf 1m*	9.2 4.7	19.7	1.8	.041	.001	.44	1.39	.006	.035	9.5	35	13	380
Run #1 Aug 24	19:55	surf 1m	8.3 7.6	24.8	3.0	.061	.001	.002	.95	.002	<.005	10.5	36.5	13	350
Run #2 Aug 25	06:25	surf 1m	6.9 6.9	22.3	2.6	.056	.004	.032	1.05	.002	<.005	10.5	38	13	353
Run #3 Aug 25	17:05	surf 1m	9.2 8.2	24.2	3.0	.064	.002	.008	1.02	.001	<.005	11	40	15	360
Run #4 Aug 26	7:00	surf 1m	6.7	23.0	2.2	.060	.002	.032	.92	.002	<.005	10.5	45	14	365

Appendix #5 continued

STATION 7A

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (^{o}C)	BOD_5 (mg/l)	PHOSPHORUS (mg P/l) Total	PHOSPHORUS (mg P/l) Sol.	NITROGEN F.A.	NITROGEN TKN.	NITROGEN NO_2	NITROGEN NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm^3)
Feb 18 & 19	———	———													
Mar 11	———	———													
June 24	11:40	surf/1m*	13.3/8.7	25/24.4	7.0	.206	.003	1.28	3.50	.080	.200	27	95	17	540
Jul 14	11:45	surf/1m	8.8/7.4	20.1	2.2	.089	.002	.420	1.39	.013	.055	12.5	30.5	11	385
Run #1 Aug 24	19:14	surf/1m	11.2/10.6	24.8	3.6	.130	.003	.012	1.12	.001	<.005	19	39.5	17	395
Run #2 Aug 25	07:00	surf/1m	8.1/8.1	22.8	2.8	.154	.004	.012	1.20	.001	<.005	19	39	19	400
Run #3 Aug 25	17:35	surf/1m	12.3/11.9	24.2	4.6	.215	.003	.016	1.60	.001	<.005	28	41	23	415
Run #4 Aug 26	06:35	surf/1m	8.6/8.5	23.5	3.2	.118	.003	.014	1.04	.001	<.005	22.5	43.5	17	400

STATION 10

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (^{o}C)	BOD_5 (mg/l)	PHOSPHORUS (mg P/l) Total	PHOSPHORUS (mg P/l) Sol.	NITROGEN F.A.	NITROGEN TKN.	NITROGEN NO_2	NITROGEN NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm^3)
Jun 24	12:25	surf/1m	11.3/9.3	24.5/25	6.5	.156	.004	.740	3.56	.094	.246	22	75	15	477
Jul 14	12:40	surf/1m	7.3/3.8	20.7	2.2	.077	.005	.270	1.30	.013	.072	12.5	24.5	12	375
Run #1 Aug 24	18:58	surf/1m	8.6/8.4	24.2	3.2	.076	.004	.004	.88	.001	<.005	12.5	32.5	13	375
Run #2 Aug 25	07:05	surf/1m	7.7/7.7	22.5	2.6	.100	.003	.010	1.10	.002	.025	12.5	37	29	380
Run #3 Aug 25	17:45	surf/1m	10.0/8.9	24.3	3.4	.104	.005	.002	1.10	.002	<.005	14	35	17	385
Run #4 Aug 26	06:25	/1m	7.0/7.0	23.0	3.4	.114	.003	.012	1.16	.002	<.005	15.5	38	44	395

Appendix 5 continued Survey Results

STATION 7B

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (°C)	BOD_5 (mg/l)	PHOSPHORUS Total (mg P/l)	Sol.	NITROGEN F.A.	TKN.	NO_2	NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm^3)
Jun 24	12:00	surf	2.7	25.0	8.0	1.44	1.05	3.00	4.80	.030	<.005	135	90	19	880
Jul 14	12:10	"	5.4	20.5	3.6	.560	.042	1.45	2.50	.10	.185	92	70	5.5	700
Run #1 Aug 24	19:24	"	16.3	26.5	12.0	.810	.30	.026	3.10	.002	<.005	140	90	18	820
Run #2 Aug 25	06:40	"	0.6	19.2	8.0	.640	.52	.50	2.98	.024	.016	155	100	20	920
Run #3 Aug 25	17:10	"	14.4	26.3	12.0	.480	.195	.002	2.00	.001	<.005	105	73	15	680
Run #4 Aug 26	06:40	"	0.6	24.0	7.5	.745	.36	.34	2.40	.007	<.005	100	70	37	700

STATION 7C

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (°C)	BOD_5 (mg/l)	PHOSPHORUS Total (mg P/l)	Sol.	NITROGEN F.A.	TKN.	NO_2	NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm^3)
Jun 24	12:10	surf	3.7	25.0	14	1.60	1.13	3.40	5.2	.200	.145	140	90	42	900
Jul 14	12:00	"	7.0	20.5	6.5	.780	.70	2.65	3.7	.30	.380	145	95	8.6	920
Run #1 Aug 24	19:32	"	5.3	23.5	7.5	.720	.310	.280	3.08	.060	.075	165	100	21	920
Run #2 Aug 25	06:50	"	5.4	21.0	8.0	.540	.31	.40	2.05	.048	.062	175	100	18	920
Run #3 Aug 25	17:25	"	7.5	24.3	6.0	.700	.30	.250	2.98	.057	.088	170	115	15	920
Run #4 Aug 26	06:50	"	4.8	24.0	24.0	.920	.34	.320	3.85	.066	.079	165	100	17	920

STATION 8-STP

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (°C)	BOD_5 (mg/l)	PHOSPHORUS Total (mg P/l)	PHOSPHORUS Sol. (mg P/l)	NITROGEN F.A.	NITROGEN TKN.	NITROGEN NO_2	NITROGEN NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm³)
Feb 18 & 19		outfall	3.3	2.5	32.0	4.20	4.20	20.4	25.5	.009	.005	240	160	10	1570
Mar 11		"	3.8	1.8	20.0	2.65	2.00	13.8	18.4	.006	.005	195	110	8.9	1200
Jun 24	9:15	"	5.9	24.5	5.0	1.45	1.25	3.8	5.3	.080	.070	143	90	6.8	900
Jul 14	09:45	"	7.0	18.8	6.0	.975	.75	3.05	5.45	.25	.245	150	95	10	930
Run #1 Aug 24	21:20	"	7.0	22.3	11.0	.720	.350	.50	3.60	.051	.049	160	100	28	920
Run #2 Aug 25	04:30	"	6.5	21.0	7.0	.700	.25	.32	2.80	.038	.042	180	100	21	910
Run #3 Aug 25	19:05	"	9.3	24.0	7.0	.760	.23	.158	3.58	.044	.051	175	95	16	910
Run #4 Aug 26	04:25	"	6.8	22.5	24.0	.760	.32	.354	3.30	.058	.062	168	100	19	920

STATION 9-STP

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (°C)	BOD_5 (mg/l)	PHOSPHORUS Total (mg P/l)	PHOSPHORUS Sol. (mg P/l)	NITROGEN F.A.	NITROGEN TKN.	NITROGEN NO_2	NITROGEN NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm³)
Feb 18 & 19		outfall	4.1	2.5	38.	2.85	2.30	18.6	25	.012	<.005	**	**	17	1420
Mar 11		"	4.1	2.5	20.	1.76	.350	9.50	14.2	.126	.224	160	115	21	1090
Jun 24	9:45	"	5.2	24.5	46.	2.45	.220	7.20	15.3	.170	.200	165	110	63	1040
Jul 14	10:10	"	8.3	18.4	20.	1.23	.250	2.30	9.80	.30	.710	160	90	69	990
Run #1 Aug 24	—	—													
Run #2 Aug 25	04:50	"	8.4	21.0	20.	1.64	.350	3.72	8.00	.26	.680	170	150	48	1040
Run #3 Aug 25	19:20	"	5.9	24.0	25.	.500	.360	3.42	8.85	.18	.345	340	105	41	1050
Run #4 Aug 26	04:40	"	5.2	23.0	24.	.725	.315	3.50	4.00	.285	.715	175	110	45	1070

STATION 11

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (^oC)	BOD_5 (mg/l)	PHOSPHORUS Total (mg P/l)	PHOSPHORUS Sol. (mg P/l)	NITROGEN F.A.	NITROGEN TKN.	NITROGEN NO_2	NITROGEN NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm^3)
Feb 18 & 19		1m	7.2	0.2	3.0	.070	.001	.830	1.82	.005	.245	16.5		10	425
Mar 11		1m	9.2	0.0	1.6	.048	.004	.310	1.22	.011	.699	13.5	36	9.4	430
Jun 24	13:10	surf / 1m	10.7 / 10.2	24.8	10.0	.146	.003	.381	2.18	.091	.249	20.5	70	29	452
Jul 14	13:30	surf / 1m	7.3 / 4.6	19.8	2.2	.082	.004	.182	1.15	.015	.060	12	25	11	365
Run #1 Aug 24	18:45	1m	10.4	24.0	3.2	.072	.003	.004	.92	.001	<.005	13	30.5	10	400
Run #2 Aug 25	07:15	1m	7.7	22.6	3.2	.084	.002	.006	1.02	.002	<.005	13.5	32.5	19	393
Run #3 Aug 25	17:50	surf / 1m	10.0 / 8.8	24.0	3.2	.088	.003	.004	1.06	.002	<.005	13	39.5	14	395
Run #4 Aug 26	06:15	surf / 1m	8.0 / 8.0	23.0	2.6	.076	.003	.022	1.12	.002	<.005	12.5	32.5	20	390

STATION 12

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (^oC)	BOD_5 (mg/l)	PHOSPHORUS Total (mg P/l)	PHOSPHORUS Sol. (mg P/l)	NITROGEN F.A.	NITROGEN TKN.	NITROGEN NO_2	NITROGEN NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm^3)
Jun 24	13:20	surf / 1m	8.6 / 8.5	24.5	4.4	.102	.002	.180	1.71	.035	.095	13.5	39	9.6	370
Jul 14	13:45	surf / 1m	8.0 / 7.8	20.8	1.8	.056	.003	.160	1.00	.016	.084	10.5	23	9.9	355
Run #1 Aug 24	18:32	1m	8.7	24.0	2.8	.075	.005	.002	1.09	.001	<.005	13	28	11	405
Run #2 Aug 25	07:25	1m	7.8	22.2	2.2	.082	.002	.016	.94	.001	<.005	13	30	14	410
Run #3 Aug 25	17:55	surf / 1m	9.6 / 9.3	24.2	2.6	.062	.003	.002	.88	.002	<.005	14	40	17	410
Run #4 Aug 26	06:10	1m	8.1	23.0	2.2	.064	.003	.012	.90	.002	<.005	13.5	31.5	11	405

Appendix #5 continued   Survey Results

STATION 13

DATE	TIME	SAMP.	D.O. (mg/l)	TEMP. (°C)	BOD_5 (mg/l)	PHOSPHORUS Total (mg P/l)	PHOSPHORUS Sol. (mg P/l)	NITROGEN F.A.	NITROGEN TKN.	NITROGEN NO_2	NITROGEN NO_3	Cl^- (mg/l)	$SO_4^=$ (mg/l)	SUSP. SOLIDS (mg/l)	COND. (umhos/cm^3)
Feb 18 & 19	—	—													
Mar 11		1m	8.8	0.0	1.8	.073	.002	.560	1.47	.009	.681	14.5	36	7.8	410
Jun 24	13:30	surf / 1m	8.2 / 8.0	24.5	4.8	.082	.004	.042	1.53	.005	<.005	10.5	26	12.0	335
Jul 14	14:15	surf / .6m	10.9 / 10.8	20.8	3.4	.076	.002	.006	1.33	.013	.032	10	20	13.0	355
Run #1 Aug 24	20:30	surf	10.4	24.3	3.0	.073	.002	.004	1.03	.002	<.005	16	47	12.0	425
Run #2 Aug 25	07:35	surf	8.8	22.1	3.0	.124	.002	.002	1.24	.001	<.005	15.5	45	27	430
Run #3 Aug 25	18:00	surf	11.3	25.7	2.8	.078	.002	.008	.96	.002	<.005	15	31.5	9.0	410
Run #4 Aug 26		surf	8.2	24.0	3.0	.160	.003	.008	1.40	.002	<.005	15	40	8.9	420

APPENDIX 6 CALCULATION OF REDUCTION BOD FIGURES

BOD_5 - during low flow conditions

Qus = low flow in Scugog River upstream of the lagoon discharges = 4 cfs or 0.113 m^3/sec.

Cus = BOD_5 concentration in the River upstream of the lagoon discharges = 3.0 mg/l.

QSTP = Sewage flow during August 1976 = 4.1 cfs or 0.116 m^3/sec or 9,856 m^3/day.

CSTP = average effluent BOD_5 concentration from intensive assuming weighted mean of 2 effuent discharges = 15 mg/l.

CDS = maximum average BOD_5 concentration downstream of the lagoon discharges = 3.6 measured.

Reduction of BOD_5

$$(Cus \times Qus) + (\underset{\text{reaching main river}}{CSTP} \times QSTP) = CDS \times QDS$$

$$(3.0 \times 0.113) + (CSTP \times 0.116) = 3.6 \times 0.229$$

$$CSTP = 4.2 \text{ mg/l}$$

$$\% \text{ reduction} = \frac{\text{CSTP at outfall - CSTP reaching main river)}}{\text{CSTP at outfall}}$$

$$= \frac{15 - 4.2}{15} \times 100 \quad 70\%$$

Downstream BOD_5 concentration assuming 70% reduction

$$(Cus \times Qus) = (CSTP \times \% \text{ reduction} \times QSTP) = CDS \times QDS$$

$$(3.0 \times 0.113) + (15{,}0 \times 0.30 \times 0.114) = CDS \times 0.229$$

$$CDS = 3.6 \text{ mg/l}$$

APPENDIX 7 Phosphorus Budget for Sturgeon Lake (KgP/yr) under various municipal loading conditions with predicted spring sphosphorus, chlorophyll a and Secchi disc

SOURCE	1972*	1976 (existing)		With 17,250 people eff.P 1.0 mg/l	With 17,250 people eff.P 0.3 mg/l
Lindsay	10,800	8,200		5,830	1,750
Fenelon Falls	-	400		300 x	90
Other local inputs	1,230	1,230	)		
Main channel input	16,200	16,200	)		
Scugog River (not	13,070	13,070	)		
including lagoons)			)	assumed the same	
Other drainage	3,430	3,340	)		
Precipitation	1,050	1,050	)		
Fish export	-130	-130	)		
Total Supply	46,750	43,450		40,980	36,690
Loading ($mgm^{-2}yr^{-1}$)	993	922		870	779
+[P] (mg/l)	23	21		20	18
+[CH] (mg/l)	6.8	6.0		5.6	4.8
+ S.D. (m)	2.4	2.5		2.6	2.7

* taken from the Kawartha Lakes Water Management Study (1976)
+ calculated according to Dillon (1974)
x assuming an ultimate population of 2,400 and an effluent concentration of 1 mg/l.